THE BOEING COMPANY
AERO-SPACE DIVISION
LAUNCH SYSTEMS BRANCH

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TITLE THRUST RING SPLICE ANGLE INVESTIGATION

MODEL NO. SAT V/S-IC CONTRACT NO. NAS8-5608

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ABSTRACT

The failed thrust ring splice angle (60B18616-1), discovered during the post test shake down inspection of the S-IC "D" vehicle, was sent to the Michoud M&P Laboratory. Standard metallurgical testing and electron fractography revealed that the crack inception was on the faying side of the angle and was due to stress corrosion.

KEY WORDS

Stress Corrosion

Electron Microscopy

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1.0 OBJECT

To determine cause of failure of splice angles used on the thrust rings of the "D" vehicle.

2.0 BACKGROUND

Failure of thrust ring splice angles, 60B18616-1, (UER 26314) was reported following the post test shakedown inspection of the "D" vehicle. One angle of the several that failed, was delivered to the Materials and Processes Group for metallurgical analysis of the failure.

3.0 CONCLUSIONS

1) The failure of the splice angle investigated is attributed to stress corrosion.

2) Initiation of crack was from the faying side of the angle.

4.0 RECOMMENDATIONS

1) If a splice angle must be used and a reduction in strength of 5 to 10% can be tolerated, the T73 temper should be called out.

2) If retrofit isn't possible current installations should be inspected for failure immediately prior to use and any failed parts replaced.

3) All angles should be installed with little or no fit up stresses or static service loads.

5.0 PROCEDURES AND RESULTS

1) One failed angle and three unfailed angles were received by the Materials and Processes Group. All angles were stripped of any coating and penetrant inspected. Only the obviously cracked angle showed failure indications. One group of indications showed failure initiated along the back of the angle propagated through to the fillet tangent point. Another indication showed a crack initiating in a fastener hole from the back side of the angle.

2) Chemical analyses showed the Material to be 7075 aluminum alloy.

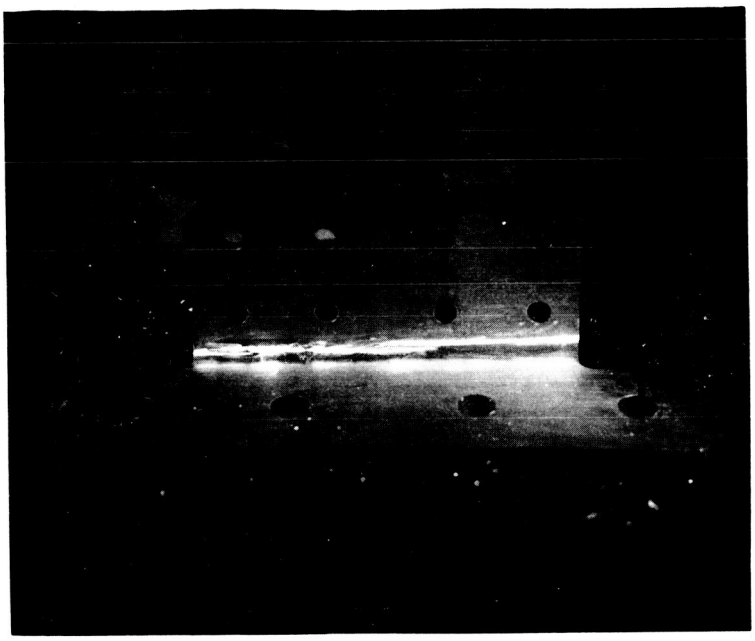
3) Tensile tests showed that mechanical properties were within specification requirements.

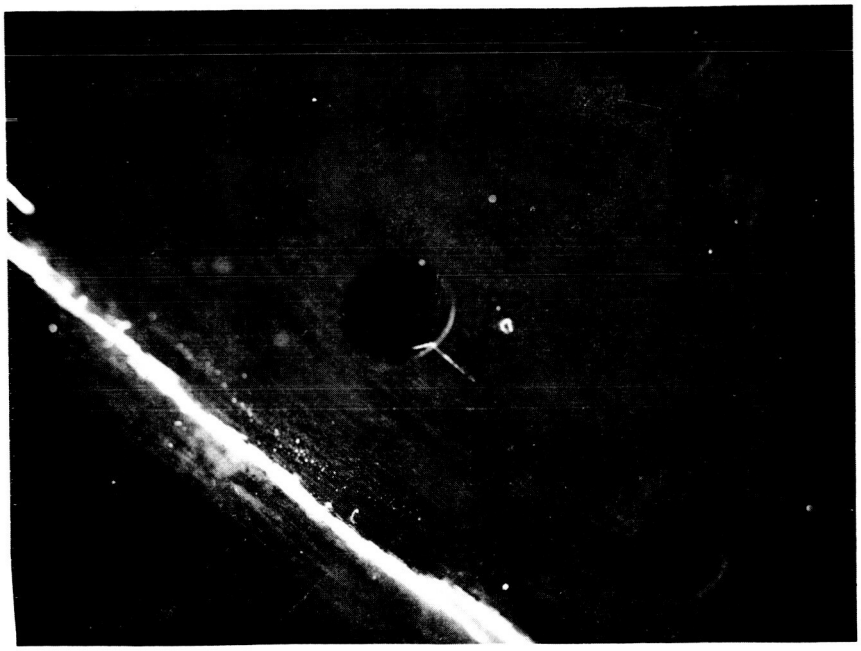
5.0 PROCEDURES AND RESULTS (Continued)

4) A specimen of the primary fracture was forwarded to the Aerospace Division M&P laboratories for electron microscope fractographic analysis. This analysis confirmed the original analysis that the mode of failure was stress corrosion.

6.0 DISCUSSION

This angle was cut from a large "T" extrusion and the face of the resultant angle from which the crack initiated was heavily machined to the drawing requirements. No further heat treatment was performed on the part thus the machined surface contained high residual tension stresses incurred in solution heat treatment.





PHOTOGRAPHS OF PENETRANT
INDICATIONS

FIGURE 1

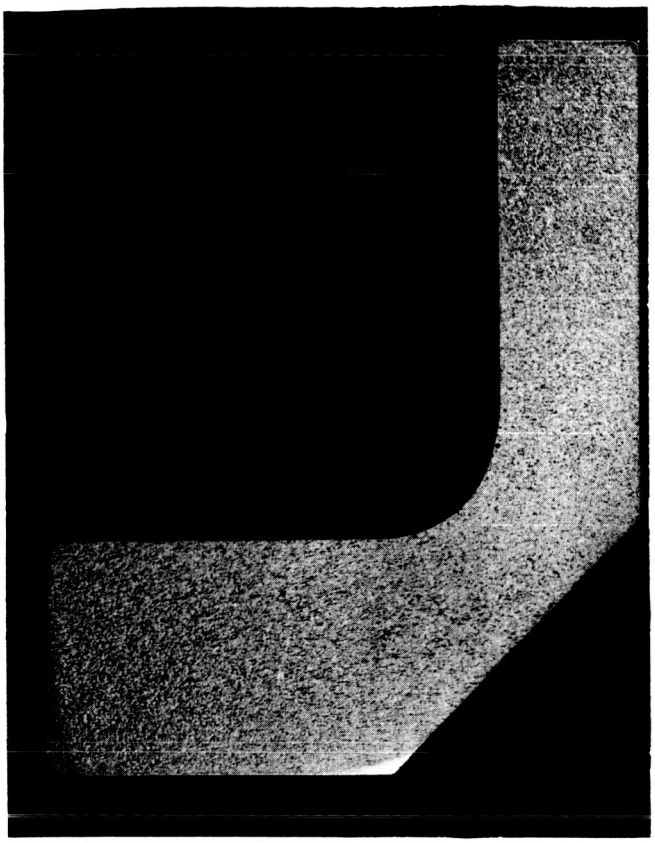
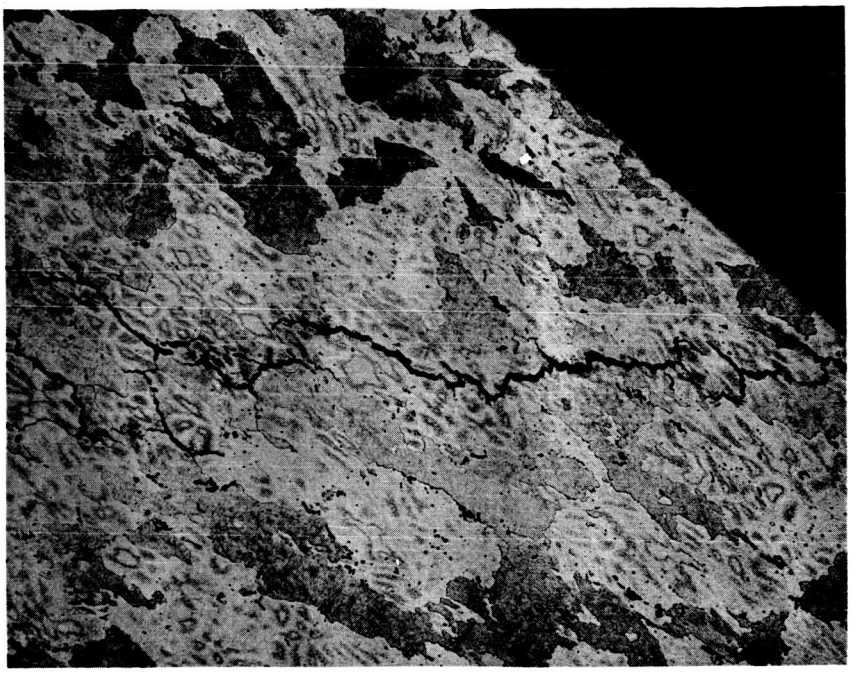


FIGURE 2 - Left

Macro Etched Cross Section of Angle

FIGURE 3 - Right

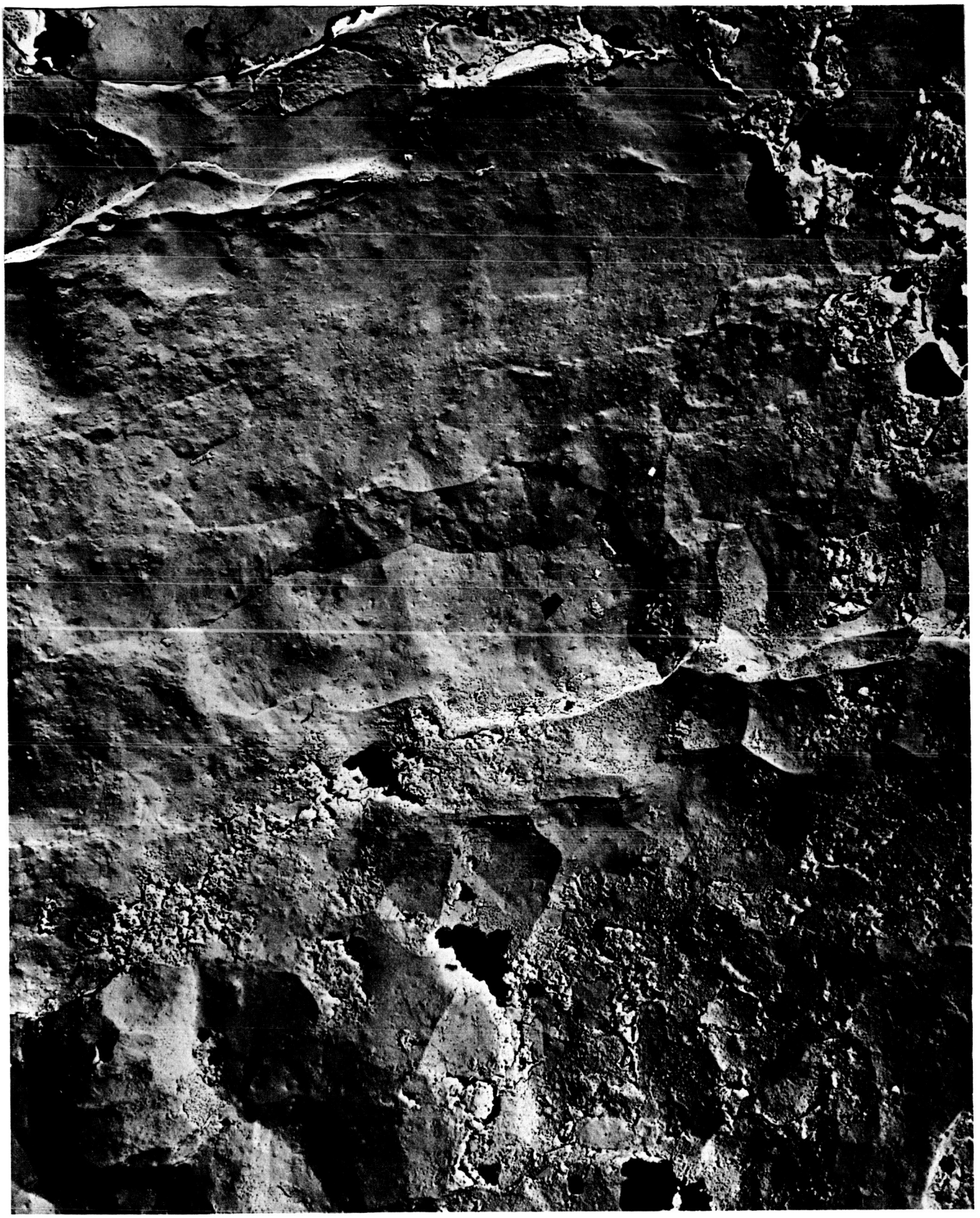
100X Photo micrograph Showing Nature of Cracking of Radius Failure. Note Inter Granular Pathway and Branching Nature of Cracks.



100X
PHOTO OF CROSS SECTION OF CRACK IN HOLE

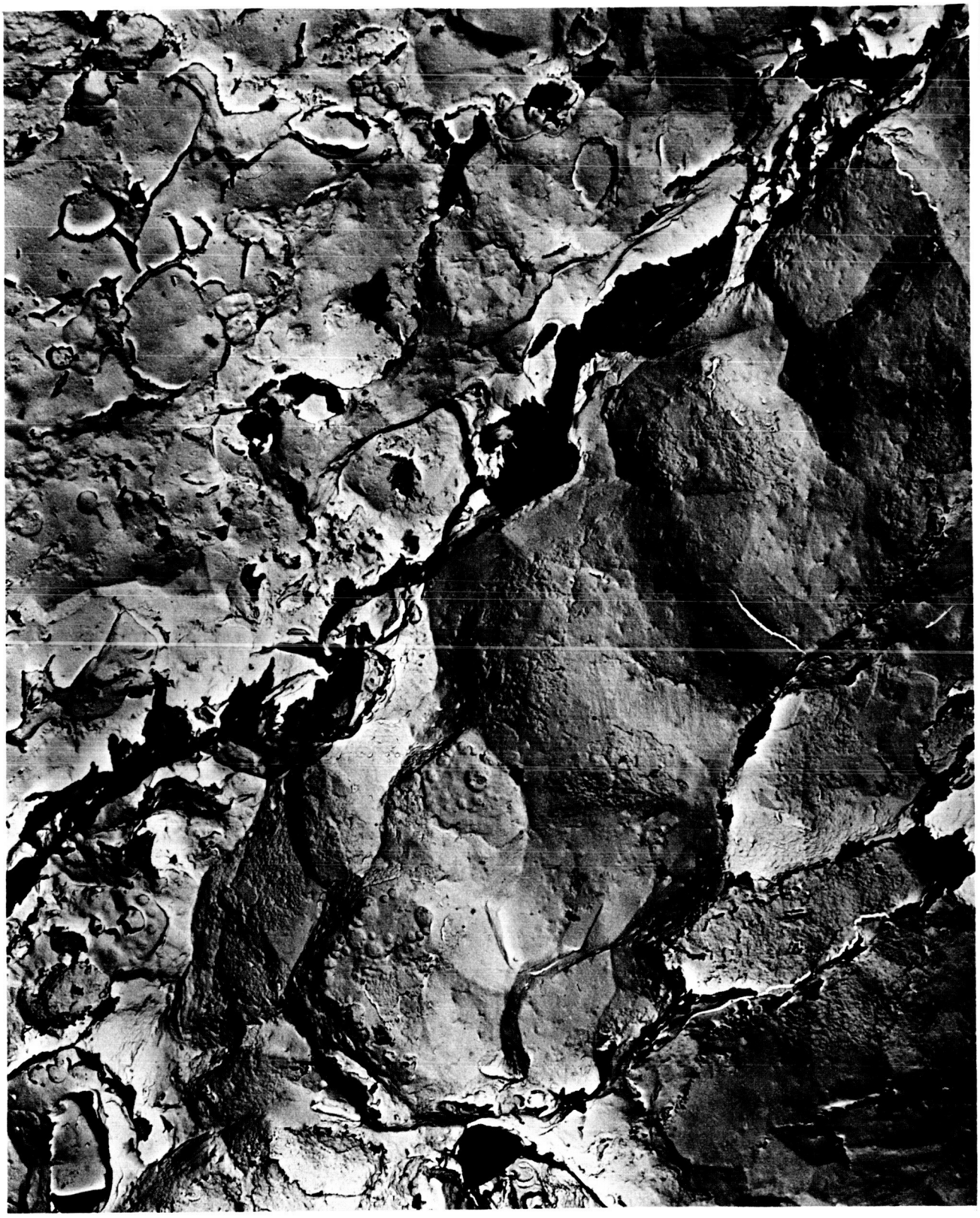
100X
PHOTO OF SAME AREA AS ABOVE WITH HEAVIER ETCH TO OUTLINE GRAINS

FIGURE 4



4400X ELECTRON PHOTO MICROGRAPH OF FAILED ANGLE FRACTURE FACE SHOWING CORROSION AND INTERGRANULAR FAILURE.

FIGURE 5



4400X ELECTRON PHOTOMICROGRAPH OF FAILED ANGLE FRACTURE FACE SHOWING INTER GRANULAR FAILURE AND SECONDARY CRACKING.

FIGURE 6